Amendments in the specification

1) Please replace the paragraph beginning on line 12 of page 3 with the following paragraph:

The pulses produced by a laser may be altered using an etalon. Etalons have been previously used to control the spectrum in mode-locked lasers. An etalon uses two parallel reflecting surfaces separated by a known distance. Interference of light reflected or transmitted from the two surfaces reinforces certain wavelengths of light, while tending to cancel out others. It is well known to use an etalon to affect the spectrum of a laser to lengthen or shorten optical pulses in a mode-locked laser. Alternatively the etalon may be used to optimize the relation between the temporal and frequency domains of the laser spectrum or adjust the distribution of power amongst the various modes of the laser. Prior art etalons have been separate discrete elements. Consequently, these etalons are difficult to implement in a mode-locked laser because they are difficult to align properly. Etalons must generally be temperature and vibration stable. In short, an etalon usually adds <u>to</u> the complexity of construction and cost of a mode-locked laser.

2) Please replace the paragraph beginning on line 3 of page 10 with the following paragraph:

With respect to substrate **120**, the meaning of the terms "front surface" and "back surface" are, of course, dependent upon the direction of incidence of light. For example, if light traveling from ~~right~~ <u>top</u> to ~~left~~ <u>bottom</u> is incident upon the reflector **110** from the <u>top</u> ~~right~~ in Fig. **1A**, the surface **122** is the front surface and surface **124** would be the back surface. Alternatively light traveling from <u>bottom</u> ~~left~~ to <u>top</u> ~~right~~ may be incident upon surface **124** from the <u>bottom</u> ~~left~~. In such a case surface **124** would be the front surface and surface **122** would be the back surface. Both configurations are within the scope of the embodiments of the present invention. Therefore, the terms front surface and back surface may be used interchangeably without loss of generality.

3) Please replace the paragraph beginning on line 17 of page 12 with the following paragraph:

In the apparatus **100**, by contrast, the etalon formed by the surfaces **122** and **124** of the substrate operates to control the resonance location relative to the laser gain peak and laser longitudinal modes. The interaction of this resonance with the gain spectrum is the key to the device operation. The principle ~~principal~~ is that the lower reflectivity of the etalon-enhanced saturable reflector on-resonance causes increased loss for that portion of the gain spectrum. This has the effect of flattening the gain and effectively increasing the bandwidth leading to shorter pulses. An additional difference is that the prior art etalon **115** is much thinner than the etalon formed by surfaces **122** and **124** of apparatus **100**. The prior art etalon **115** is typically about 1 micron thick. Consequently, the fringes are as broad or broader than the typical laser line when the device **101** is used as a mode-locker in a mode-locked laser. The etalon of apparatus **100**, by contrast, is typically several hundred microns thick. The etalon typically has a thickness large enough to give it a free spectral range (FSR) of order 1 GHz or greater. For laser applications an FSR of order 1 GHz is of roughly comparable to or less than a typical laser gain spectrum. Multiple fringes may interact with the saturable absorber layer **116** of the apparatus **100**, to selectively shape the gain spectrum. In the prior art device **101** only one broad fringe interacts with laser gain and selective shaping of the gain spectrum does not occur.

4) Please replace the paragraph beginning on line 25 of page 16 with the following paragraph:

Fig. **4** depicts a sketch of laser gain line shape juxtaposed with the etalon reflectivity spectrum (not to scale) for a mode-locked laser of the type shown in Fig. 2. ~~Fig. 2;~~ The values shown represent the parameters of our experimental realization. By aligning an etalon reflectivity minimum with the gain peak, the peak is suppressed and the laser gain line shape is flattened. The decrease in reflectivity of the etalon on resonance increases the loss to the laser cavity. If this point of higher loss is aligned with a peak in the laser gain, then the gain

profile is flattened, as shown in Fig. **4**, by comparing the solid and dashed lines representing the laser gain profile. The laser gain line shape shown in this figure is a representative sketch, not necessarily an actual line shape for any particular laser. The asymmetry such as shown here is suggested by line shapes observed with a scanning Fabry-Perot interferometer (see <u>Figs.</u> ~~Fig.~~ **6A-6B**).

5) Please replace the paragraph beginning on line 29 of page 17 with the following paragraph:

Fig. **5** shows a detail of two portions of Fig **3**. The etalon resonance is characterized by regions of a stable, clean pulse separated by regions of a noisy pulse. In the stable regions, pulse shortening occurs as the etalon peak moves across the gain line shape when the temperature changes. In this experiment, the regions of stable operation are wider at higher temperatures. The pulse behavior as a function of temperature shows that the etalon tuning behavior is observed in a regime where the pulse is clean and well-formed, which is bracketed by a region in which the pulse <u>is</u> ~~in~~ noisy. Note that the temperature range for the stable, clean pulse increases at higher temperature under these particular experimental conditions. Since the sensitivity of pulse width change vs. temperature change is approximately constant within the resonance regions, operating at higher temperature gives greater tolerance for pulse stability. The slope of 2% for 0.1 °C temperature change within the etalon resonance makes the device relatively straightforward to stabilize with available temperature controllers. Thus a typical concern about the difficulty of stabilizing an etalon in a laser cavity is a manageable issue for our device in practical operation.

6) Please replace the paragraph beginning on line 17 of page 18 with the following paragraph:

Figs. **6A-6B** depict the effect of removing the etalon enhancement by <u>operating</u> ~~operated~~ the device with a sanded back surface to eliminate the etalon resonance~~, as shown in Fig. 6~~. In that condition, <u>(i.e., Fig. **6B**)</u> the pulse width was typically 2 times longer than

when we used etalon enhancement (i.e., Fig. **6A**) for otherwise identical laser conditions. Using etalon enhancement, we found that the best pulse width for this device and the parameters that we investigated was 29 ps at 99.7 °C.

Comments on amendments to the claims

Claims 1, 12, and 22 are currently amended to more clearly define and claim the present invention. Minor informalities of claim language that have been noticed at this time are also corrected by amendment. No new matter is introduced thereby.

Claims 20 and 21 are canceled. New dependent claim 37 is presented, and is supported by the specification, e.g., on lines 21-24 of page 16 of the specification. Thus no new matter is introduced thereby.

Comments on amendments to the drawings

Replacements for drawing sheets 1 and 3 are filed herewith. The changes made in the replacement sheets are as follows:

On replacement drawing sheet 1, a reference number 111 is added to make Fig. 1B consistent with the description on lines 5-9 of page 12 of the specification.

On replacement drawing sheet 3, "exiton" is replaced with "exciton", the correct spelling.

No new matter is introduced by these amendments to the drawings.

Comments on amendments to the specification

Minor errors and informalities that have been noticed in the specification at this time are hereby corrected by amendment. With respect to the changes to the paragraph beginning on line 3 of page 10, these changes (i.e., "left" to "bottom" and "right" to "top") follow the change in orientation of Fig. 1A that occurred when formal drawings were submitted. Accordingly, no new matter is introduced by these amendments to the specification.

DETAILED ACTION

Claim rejections: 35 USC 102

Claims 1, 3-4, 9-10, 22, 26-27, and 34-35 stand rejected under 35 USC 102(b) as anticipated by US 5,237,577, hereinafter Keller.

Independent claims 1 and 22 are currently amended to more clearly define and claim the present invention. In particular, the claimed etalon is formed by the second and modified surfaces of the substrate, and the reflector containing the saturable absorber layer is "deposited" on the second surface. Thus the saturable absorber layer of the present invention is necessarily not disposed between the second surface and the modified surface of the substrate, and this geometric relation is now explicitly recited in the claims. In sharp contrast, the teachings of Keller relate to a configuration where the saturable absorber layer is within the etalon. In geometric terms, the saturable absorber layer of Keller is between two surfaces that form the etalon. Thus the claims as amended are clearly not anticipated by Keller. Furthermore, it would not be obvious to modify Keller to meet the claim limitations by placing the saturable absorber outside the etalon, since such modification would fundamentally alter the operating principles of Keller. More specifically, the main point of Keller's teaching is to position the saturable absorber layer within the etalon to alter its behavior.

Claims 3-4 and 9-10 depend from claim 1, so the above amendments and arguments in connection with claim 1 is also responsive to this rejection of these claims.

Claims 26-27 and 34-35 depend from claim 22, so the above amendments and arguments in connection with claim 22 is also responsive to this rejection of these claims.

Claim rejections: 35 USC 103

Claims 2 and 25 stand rejected under 35 USC 103(a) in view of Keller.

Claim 2 depends from claim 1, so the above amendments and arguments in connection with claim 1 is also responsive to this rejection of claim 2.

Claim 25 depends from claim 22, so the above amendments and arguments in connection with claim 22 is also responsive to this rejection of claim 25.

Claim rejections: 35 USC 103

Claims 5, 11-16, 19-21, 28, 32-33 and 36 stand rejected under 35 USC 103(a) over Keller in view of US 6,393,035, hereinafter Weingarten.

Claims 5 and 11 depend from claim 1, so the above amendments and arguments in connection with claim 1 is also responsive to this rejection of these claims.

Independent claim 12 is currently amended to more clearly define and claim the present invention. In particular, the geometrical limitations of claims 1 and 22 are also recited in claim 12. Neither Keller, as indicated above in connection with claims 1 and 22, nor Weingarten, nor the combination thereof teach or suggest the invention as claimed in claim 12.

Claims 13-16 and 19 depend from claim 12, so the above amendments and arguments in connection with claim 12 is also responsive to this rejection of these claims. New claim 37 also depends from claim 12.

Claims 20 and 21 are canceled.

Claims 28, 32-33 and 36 depend from claim 22, so the above amendments and arguments in connection with claim 22 is also responsive to this rejection of these claims.

Claim rejections: 35 USC 103

Claims 23 and 24 stand rejected under 35 USC 103(a) over Keller in view of US 5,848,079, hereinafter Kortz.

Claims 23-24 depend from claim 22, so the above amendments and arguments in connection with claim 22 is also responsive to this rejection of these claims.

Allowable subject matter

Claims 6-8, 17-18, and 29-31 stand objected to for dependence on a rejected base claim, but otherwise stand as allowable.

Applicant appreciates this indication of allowable subject matter, and believes that current amendments to claims 1, 12 and 22 remove the need to rewrite these allowable claims in independent form at this time.

For the record, it has been noticed that rejected claim 19 depends on allowable claim 18. Clarification of this apparent clerical error is respectfully requested.